New Powerhouse Construction Lessons Learned – LBU4

Shane Richards, PE

Mechanical Engineer – Hydro

2014 NWHOF
Spokane, WA
May 21st, 11 am

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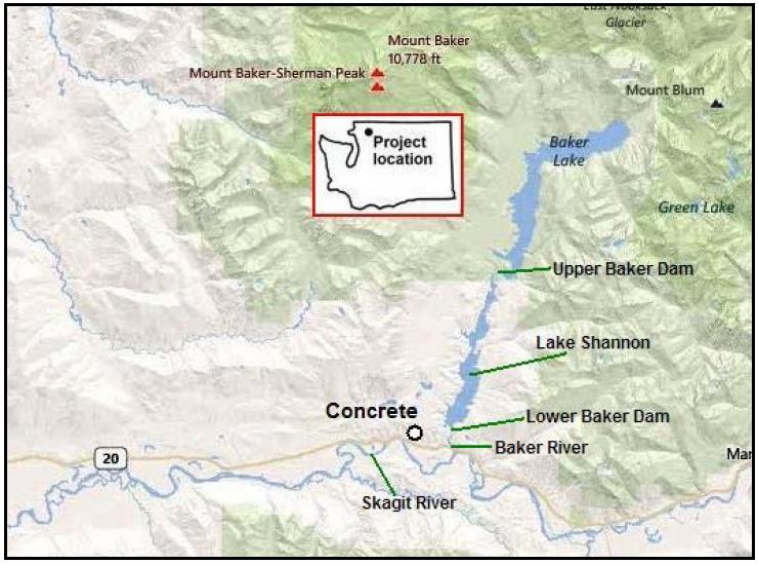
What will you learn?

- Background on LBU4
- Lessons Learned:
  - Procurement
  - Design
  - Construction
  - Commissioning
- Conclusions
- Questions?

Where is LBU4?

- South of Mt. Baker on WA State Hwy-20 just outside Concrete, WA



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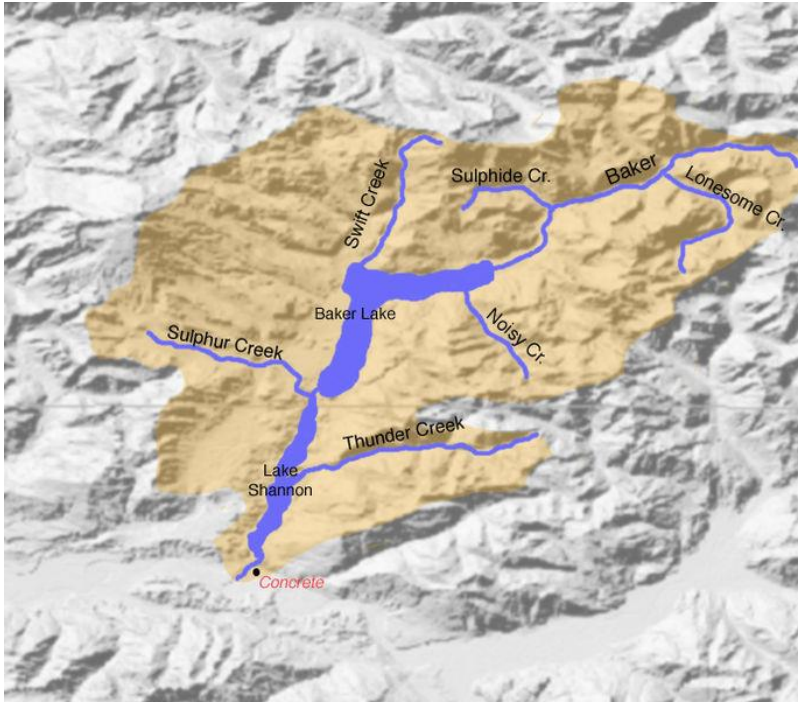
Baker River Hydroelectric Project



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FERC License Required Improvements

- 2x Floating Surface Collectors (FSCs)
- Adult Fish Trap (AFT)
- Fish Hatchery Upgrades
- Various Auxiliary Investments
- New Powerhouse – LBU4

Lower Baker Unit 4

- ~$50 MM Design-Build Contract for design & construction (PCL Construction, Black & Veatch Engineering)
- ~$11 MM Turbine Supply Package (Litostroj-Koncar – Slovenia/Croatia)
  - 30 MW or 1500 cfs Minimum Instream Flow Turbine
- SBV included – For ensuring flow continuation
- ~$20 MM ARRA Funded Tax Grant

- My Role – Project Mechanical Engineer

Lower Baker – Before & After

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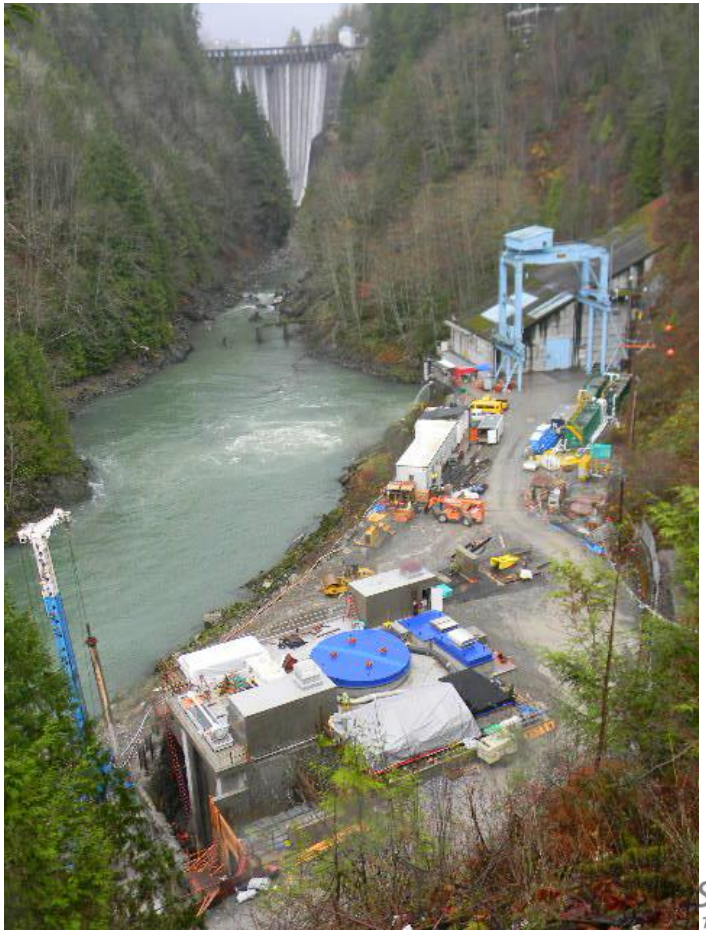
~$90MM Later



Lessons Learned – Procurement

- Take the time to review, identify, and correct any discrepancies between contract documents
- Determine a clear and confident contract order of precedence
- Begin coordinating work early and defining scope while still at a competitive advantage

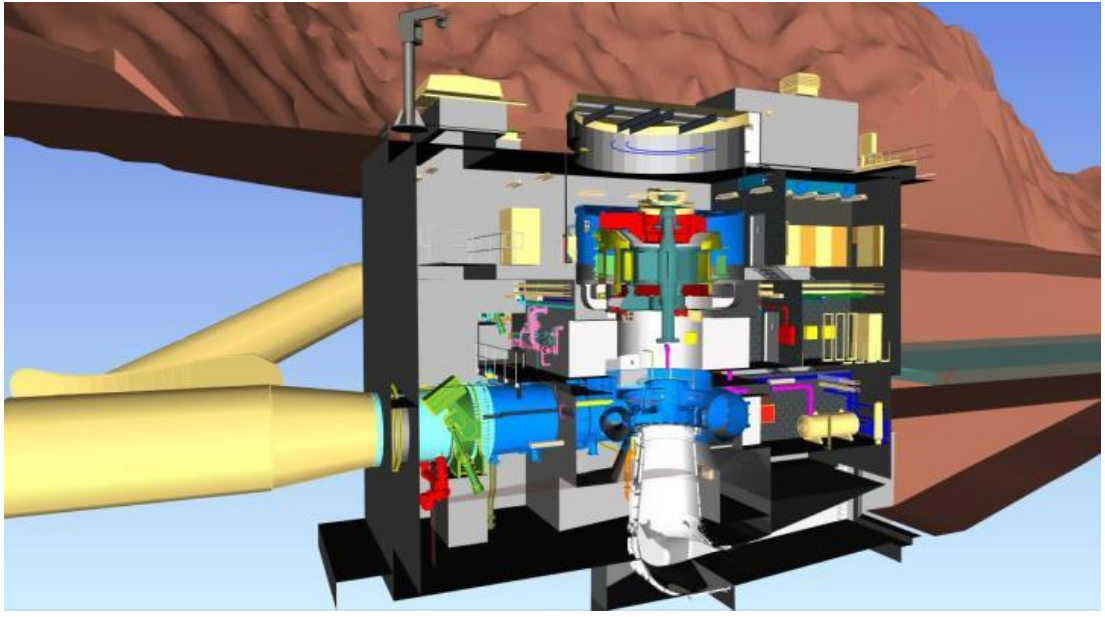
Level of Responsibility is from Left to Right (A/B/C)				
Design	**Provide**	**Install**	**Field Test**	**Commissioning**
DB	DB	DB	DB/CV	DB/CV
HTG	HTG	DB	DB/HTG/CV	DB/HTG/CV

Lessons Learned – Design

- Specify clear installation instructions and manufacturers' requirements as that impacts detailed design (concrete pours, etc.)
- Design workshops worked (to a point) but a DB/HTG/PSE combined workshop would have been very useful
- Designing & implementing a new FCS was challenging (Paul Jusak's earlier presentation)

Lessons Learned – Design (Cont)

- 3-D Design was a powerful tool – assuming the technology is available AND the model keeps up to date



Lessons Learned – Design (Cont)

- Not 100% Right!

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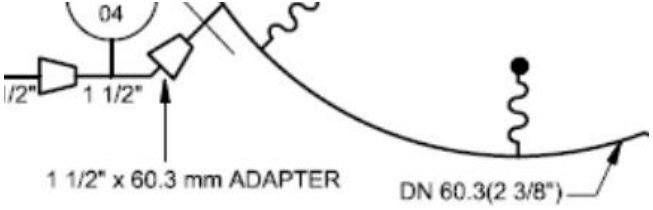
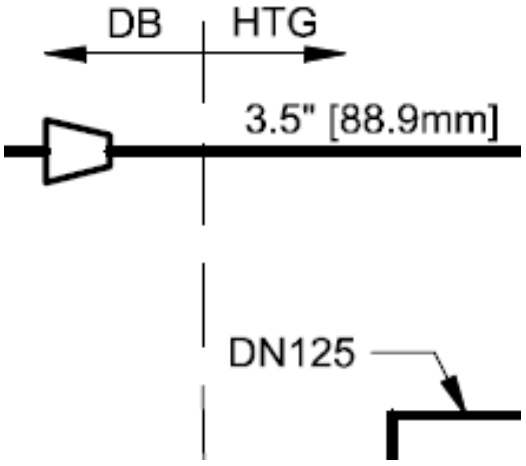
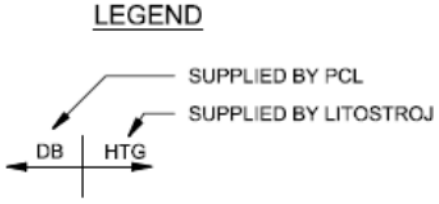
Lessons Learned – Design (Cont)

- Watch units and scope limits!







Lessons Learned – Construction

- If Design-Build is selected, specify co-located engineering requirements.
- Powerhouse cranes are expensive but the convenience of availability pays off during assembly.
- Shipping and transportation for equipment of this size requires active involvement and substantial planning.

Lessons Learned – Construction (Cont)

- Owners should provide adequate storage. You'll want it stored your way, need it, and can use it later.

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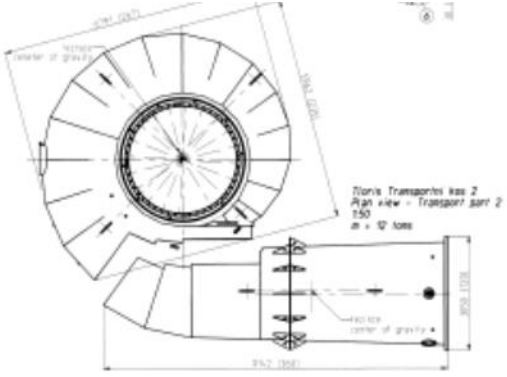
Lessons Learned – Construction (Cont)

- Understand the extent of field work required so it can be planned and scheduled ahead of time



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Lessons Learned – Construction (Shipping)

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Lessons Learned – Construction (Shipping)

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Lessons Learned – Construction (Cont)

- Clarify Standards & Preferences

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Lessons Learned – Commissioning

- Safety is the most important aspect of commissioning
- Specify company LOTO and make it a contractual requirement
- Calibration of field instruments is challenging and should be coordinated and documented in advance
- It always takes longer than a contractor thinks; track daily activities and complications accordingly

Conclusions

- Contract Consistency is very important
- Contract interface points (Owner Furnished & Contractor Provided) can cause complications during ultimate assembly
- Gather all the designers early and attempt to align designs as well as methods for tracking changes
- Proactive and involved project team members are required as the Project progresses
- Commissioning will not go as planned so plan or respond accordingly

Questions? → Shane.Richards@pse.com

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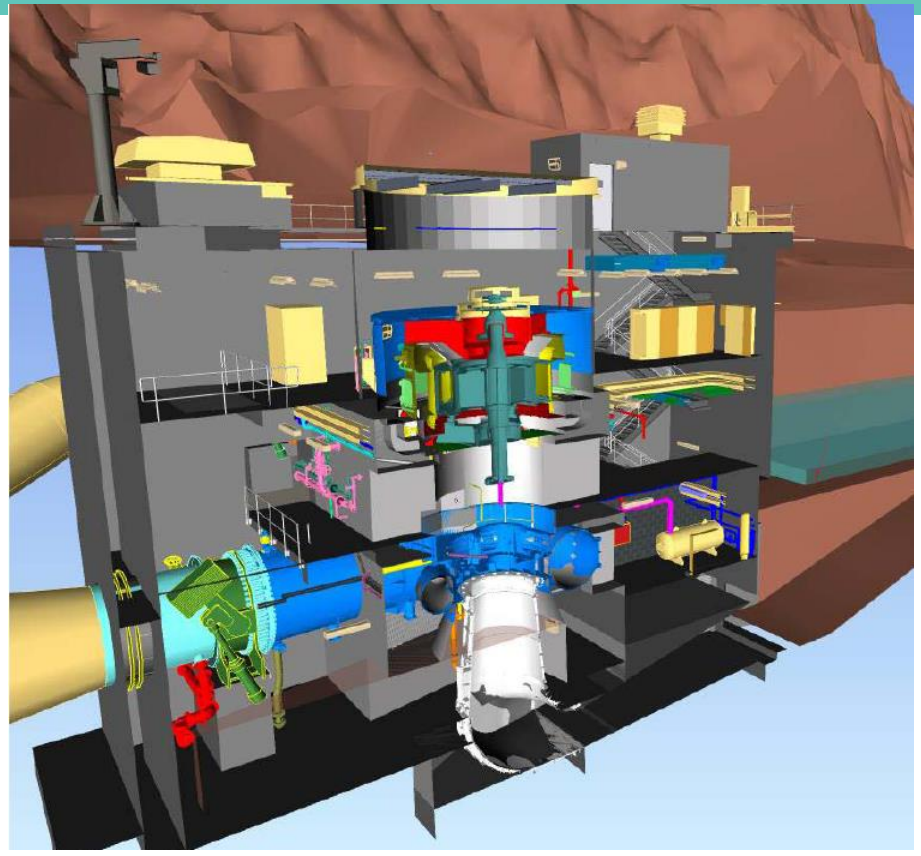
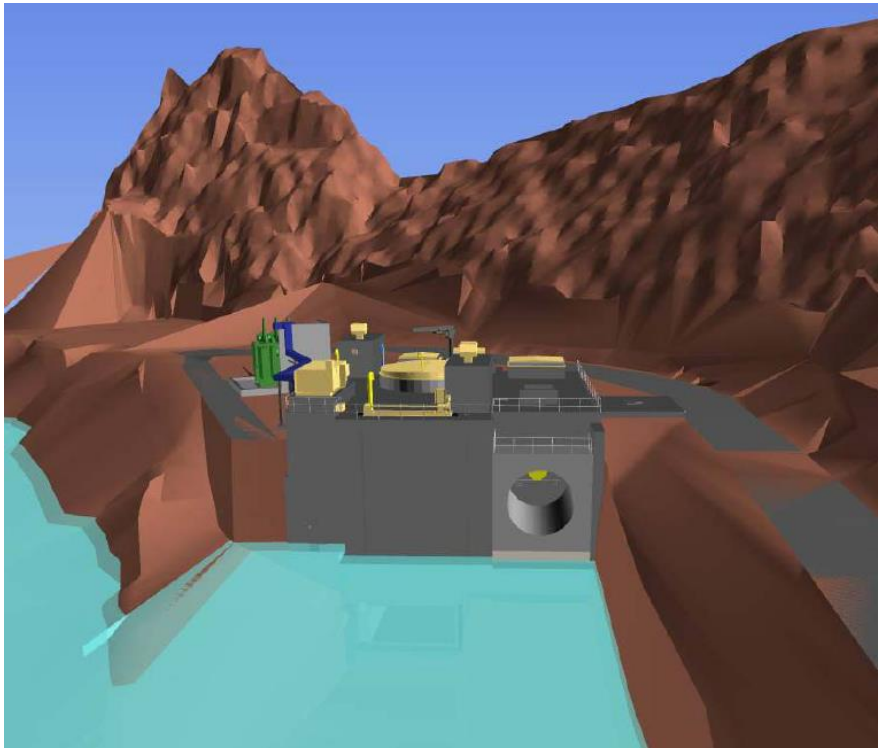
3D Model of Powerhouse Structure & Systems





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Phase 1 - Excavation

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Phase 2 - Tunneling

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Surge Tank Tie-in Work

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Phase 3 – Powerhouse Construction

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Roof Completed – Hatches Installed

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Turbine-Generator Supply

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Turbine Being Installed

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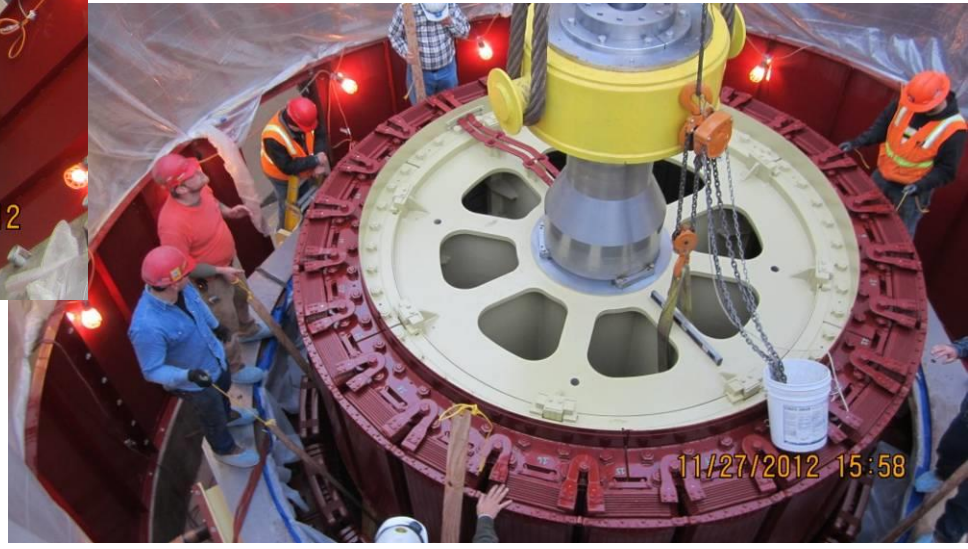
Generator Installation



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